Two new prospects are expanding the resource base of the Los Bronces mine, already one of the largest concentrations of copper mineralisation in the world. Nicky McClure reports.
The Andean region hosts one of the world’s most prospective copper belts, and two recent exploration projects, San Enrique-Monolito and Los Sulfatos, could be among Anglo American’s most significant and highest-quality copper prospects yet.

After initially being drawn to Chile in the early 1980s in a search for gold, Anglo American’s focus soon switched to copper, following a series of deals that were born after establishing a local foothold. And when the company acquired Compañía Minera Disputada de Las Condes (CMDLC) for $1.3 billion in December 2002, it began exploring highly prospective areas near the recently acquired Los Bronces operation.

Anglo American’s Los Bronces copper operation is 60 kilometres north-east of Santiago, in central Chile, at altitudes of between 3,000 and 3,500 metres above sea level. Exploration activity here led to the discovery of promising new deposits; one a kilometre away from Los Bronces at San Enrique-Monolito (SEM), and the other, Los Sulfatos, about six kilometres south of the mine, at elevations of over 4,000 metres above sea level.

Graeme Lyall, advanced exploration projects manager in Chile, says that the Los Sulfatos area showed potential early on: “There is evidence of small-scale exploratory activities that...”

**TIMELINE**

**LOS SULFATOS**

1920s
The Andes Mining Company documents the presence of porphyry copper-style mineralisation in the area.

1960s and 1990s
Short-lived exploration and drilling campaigns are carried out, but prove insufficient to determine the true potential of the prospect.

2002
Anglo American acquires CMDLC for $1.3 billion – including the Los Bronces mine and surrounding mineral concessions.

2005-2008
Four field seasons culminate in the discovery of the Los Sulfatos deposit – of a size and grade that rank it as one of the top copper discoveries in the past 30 years.

2007
SRK Consulting is contracted to engineer an eight-kilometre-long exploration tunnel to access the Los Sulfatos deposit.

2009
Italian tunnel firm SELI ships the 290-tonne tunnel boring machine from Italy to Chile in 70 containers. Excavation with the tunnel boring machine starts in August.

2010
The total tunnel advance at the end of July is 1,800 metres in difficult ground conditions.

2011
Tunnel development expected to be completed by the end of 2011.
date back perhaps 100 years. Over and above the geology of the prospect, which showed promising signs of a significant copper deposit, two drilling campaigns were undertaken by previous owners; the first at the end of the 1960s, and the second at the beginning of the 1990s. Both campaigns showed that there was copper mineralisation in the area, but failed to demonstrate the true potential of the prospect.”

And what potential there was. While SEM could contain up to 25 million tonnes of copper, early indications show Los Sulfatos may have substantially more.

DIFFICULT TERRAIN
Exploration at Los Sulfatos began with a geological reconnaissance of the area in 2004, followed by helicopter-supported drilling campaigns between 2005 and 2008. The difficult terrain, harsh climate and environmentally challenging conditions meant that field activities were restricted and could only be carried out over the limited summer periods between December and March.

The exploration drilling campaigns were carefully planned. Two field camps, housing up to 30 people, were set up in the high mountains using both modern and more traditional methods of transportation. Movement of all the equipment, personnel, food and fuel was done by helicopter, with mules carrying the team between the camps and the drill sites.

During the four field seasons, 22 holes were drilled. All the holes intersected potentially economic copper mineralisation, indicating that the Los Sulfatos deposit was substantially bigger and better quality than had been previously estimated.

A NEW APPROACH
The world-class copper deposit that these exploration and drilling efforts had revealed extended to depths of at least 1,000 metres below the surface. However, significantly more drilling was needed to determine the full characteristics of the deposit before mine development options could be considered. Extreme conditions meant the only alternative was to carry out the drilling from underground.

In 2007, SRK Consulting was contracted to engineer the development of an eight-kilometre exploration tunnel, starting from the Los Bronces operation and heading south, to provide underground access from which to drill out the resource. Conventional drill and blast methods were discarded in favour of tunnelling.

“Our investigations showed that the tunnel boring machine was not only feasible, it was potentially much faster and significantly safer than the alternatives.”

GRAEME LYALL, ADVANCED EXPLORATION PROJECTS MANAGER

Using a mechanised tunnel boring machine (TBM). Despite its marginally higher cost, TBM technology had advantages in terms of development timeframe, safety and overall project risk.

“Our investigations showed that the TBM was not only feasible, it was potentially much faster and significantly safer than the alternatives,” explains Graeme. “This was undoubtedly the best method.”

A TBM development project was awarded to Chilean construction firm Besalco in association with Spanish firm Dragados, a company with...
extensive experience in this sort of tunnelling. This led to the manufacture of a new Double Shield Universal Compact TBM with Italian firm SELI. Others participating in the project include H+E Logistik, which supplied the system that removes material from the tunnel, and Schöma, which provided locomotives for material and personnel transport.

MACHINE ASSEMBLY
Commissioning of the TBM created its own challenges. SELI completed and tested the TBM in Rome in early 2009, before taking it apart to be shipped in 70 containers to Chile – itself a massive undertaking. The TBM weighs 290 tonnes, measures 91 metres and the tunnel excavation diameter is 4.5 metres. The largest component – the main bearing – weighs nearly 50 tonnes. This and both segments of the cutter head were shipped separately.

To prepare for the TBM, an initial advance tunnel was created to enable the machine to be assembled by SELI technicians. After initial testing showed that it was working properly, the green light was given to initiate tunnel boring.

TBM excavation commenced in August 2009, almost one year after initiating the design and manufacture process. The first two-kilometre drive anticipated the most difficult ground conditions, and progress has indeed been slow and challenging during this initial drive. By the end of July 2010, the tunnel had advanced 1.8 kilometres towards Los Sulfatos.

LOOKING AHEAD
Using a TBM, the tunnel has an estimated advance rate of 400 metres per month – more than double the progress that is expected using conventional methods.

The team is considering excavating at least 20 drill stations to carry out exploration drilling. Graeme says: “We have planned for up to eight drill rigs operating in the tunnel, drilling in various directions. Information from these drill samples will be characterised geologically and analytically for copper contents.

This will help to develop a model for the deposit that will be used in mine planning and engineering studies.

“We should finish tunnelling by the end of 2011. Exploration drilling is expected to last at least three more years and then there are mining and engineering studies before mine development. It will be at least another 10 years before we can expect to start extracting copper from the ground.”

Graeme concludes: “The Los Sulfatos deposit promises to become one of the most long-lived and profitable operations in the world, lasting well beyond my lifetime. So really this is just the beginning.”

For more information, visit: www.anglochile.cl

ACKNOWLEDGEMENTS
The Los Sulfatos area had been explored for nearly a century and there is no doubt that this discovery is the result of a number of contributions. Timing is perhaps a key factor, as technology, conditions and world demands change. For this particular deposit, Anglo American was fortunate to be there at the right time with the right strategy and with the right people.

The company’s former leader, the much admired and respected late Nigel Grant, former consulting geologist for Anglo American South America, was key to promoting the exploration potential and value of the Disputada assets during the acquisition process in 2002, and this was perhaps a significant factor that led to completing the winning bid.

Chris Carlon followed and, eventually, the discovery was led by and came to fruition through current head of Andes exploration Vicente Irarrázaval, Chief project geologists who lived through the harsh conditions on site included Cristian Spröhnle and then William Robles. Juan Carlos Toro was instrumental in providing valuable geological contributions. The team also included a number of geologists and supporting staff who are proud of this achievement.